SUGAR-BEET BLOCKING *by machinery*

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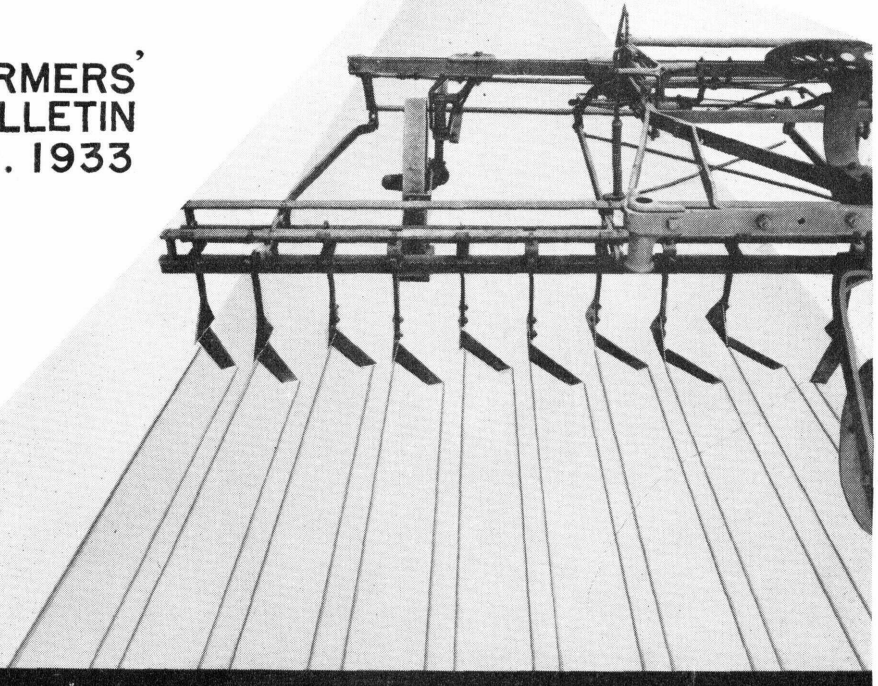

U.S. DEPARTMENT OF AGRICULTURE

THE thinning of sugar beets by hand or with the aid of a hoe is a tedious and back-breaking job. For a number of years agricultural engineers have been working on the design of machinery and the perfecting of methods to permit this operation to be done mechanically. This bulletin describes the equipment required and the methods that experience has shown to be the best adapted to the operation. Because of the shortage of manpower for farm work, information of this kind is particularly valuable at this time. Existing cultivating tools can be readily adapted to mechanical blocking.

This bulletin supersedes Leaflet 97, Cross-blocking Sugar Beets by Machine.

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SUGAR-BEET BLOCKING BY MACHINERY

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INTRODUCTION

BLOCKING and thinning of sugar beets, as usually done with long- or short-handed hoes and finger thinning, requires a great deal of hand labor. Much of this hand labor can be eliminated through mechanical blocking or mechanical thinning. In some cases this labor is saved at the expense of a small reduction in yield, but the saving often more than repays the loss in tonnage. Mechanical thinning enables growers to thin or partially thin their beets much faster; it lengthens the available time for thinning; and in some cases it saves the crop when hand labor is scarce.

Two thinning practices are used with mechanical blocking. The first is to follow the mechanical blocking with hand thinning to single plants, a practice introduced several years ago and now much used in the North Central and the Intermountain States. The second practice is to follow the mechanical blocking with long-handled-hoe thinning only or to do no thinning at all. This is a more recent development, mostly experimental.

The man labor required for blocking and thinning, as ordinarily done in California, usually ranges from 12 to 20 man-hours per acre. The range in the Intermountain districts is somewhat higher, perhaps because thinning is better done.

Where mechanical blocking was followed by finger thinning to singles, labor savings of about 25 percent were obtained in experiments by the United States Bureau of Agricultural Chemistry and Engineering.[1] The United States Bureau of Plant Industry found labor savings of from 30 to 40 percent on a 2-year series of mechanical and hand blocking and thinning experiments throughout western United States. These labor savings were obtained without loss in yield or percent of sugar, and in many cases there was a slight gain in favor of mechanical blocking.

Where mechanical blocking is not followed by finger thinning to singles, but is followed by long-handled-hoe thinning or no thinning, the labor savings are greater. Experiments have shown savings of from 65 to over 95 percent of the man labor of thinning. With no thinning the only man labor involved is that of mechanical blocking and ranges from one-half man-hour to 2 or 3 man-hours per acre. In some plantings this type of blocking and thinning has been done

[1] Formerly the Bureau of Agricultural Engineering.

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without loss in yield or percent of sugar, but averages for several years show a loss of 9.4 percent in yield, usually partially or entirely compensated for by savings in labor.

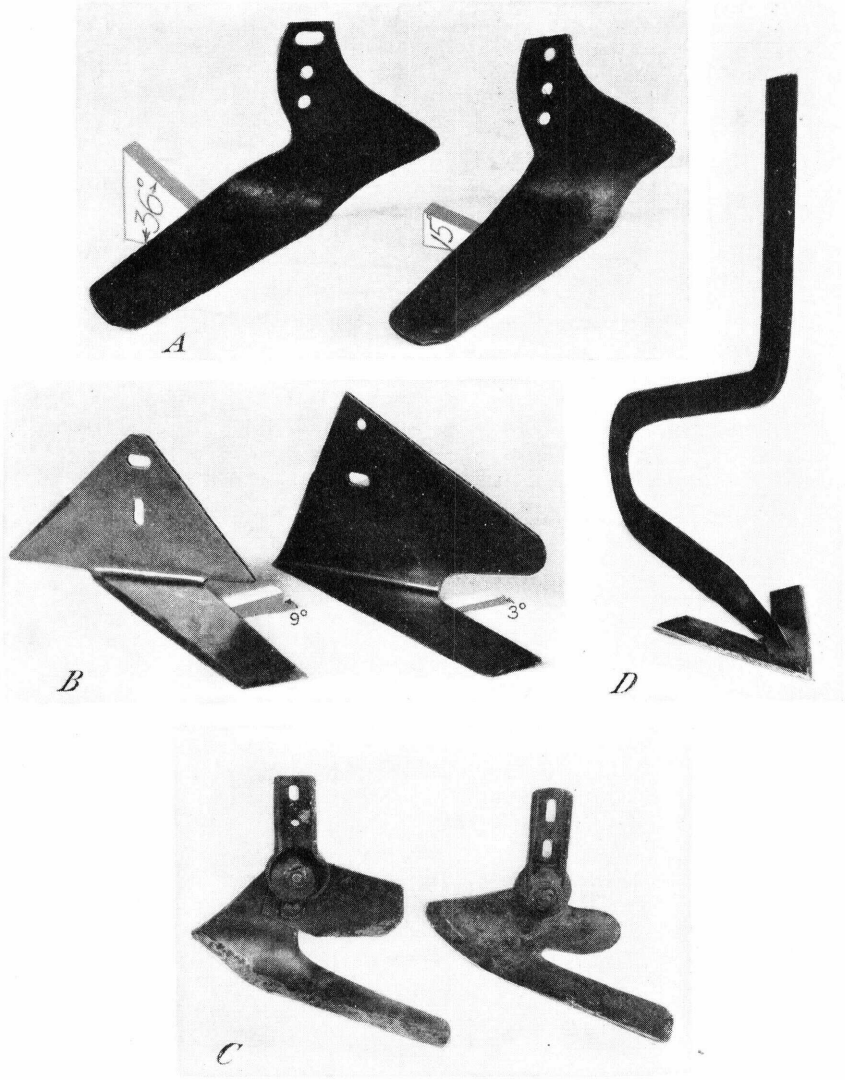

FIGURE 1.—*A*, Large and medium suction weeder knives for sugar beets; *B*, square-turn weeder knives for cultivating sugar beets; *C*, two makes of adjustable weeder knives used especially for cross blocking sugar beets; *D*, duckfoot knife developed by a large western sugar company, for cross blocking sugar beets.

Mechanical blocking usually can be done as cross blocking at right angles to the rows, a beet cultivator with markers similar to those used on a beet planter being used. Such equipment requires only the purchase of additional knives, and often those on hand are satisfactory.

Cross blocking cannot be used on bed planting, and special down-the-row machines must be used. Cross blocking has not been successful on the peat soils of the Sacramento-San Joaquin Delta region. Special rotary cultivators developed in that district for beet and other cultivation have been used with some success for cross blocking on the peat soils, and further adaptation may prove them to be even more effective. Chemical blocking with some herbicide to destroy the beets between the blocks may also prove feasible.

Types of Knives Used

Different types of knives have been found satisfactory for cross blocking. Weeder knives or sweeps of suitable length and not too much pitch or suction are satisfactory. Knives with considerable suction, like the left-hand one in figure 1, *A*, will throw too much dirt and are likely to cover the plants. The square-turn knives (fig. 1, *B*) are well adapted for cross blocking as they give a more definite margin, but they may have a tendency to break out the uncut blocks where narrow blocks are left.

Adjustable knives (fig. 1, *C*) with which different widths of cut can be obtained are desirable, particularly for some spacing setups, but they require extra care to set up properly.

A special, nearly flat, duckfoot knife with a long rear offset standard having a sharp front edge (fig. 1, *D*) has been developed for cross blocking. It is very effective because it readily sheds cut-out beets and trash. The usual type of duckfoot knife tends to furrow somewhat, particularly if cut-out beets, weeds, or trash accumulate on the standard, and beets in uncut blocks may be covered.

In trashy or crusted soil, it may be necessary to use cultivator disks ahead of the knives (fig. 2). However, the blocking can usually be done without the disks, and if it is possible to do without them they should not be used because they add to the load on the tool bar and it takes longer to set up the equipment. The usual concave cultivator disks will cover the beet blocks unless the width of cut is comparatively wide and the speed of travel is reduced.

Rolling cutters or sliding shields to keep the plants from being covered are not necessary if the knives do not have too much pitch or suction. The cross-blocker set-up should be kept as simple as possible. This will expedite the setting-up of the machine and will allow beets and trash to work back through the knives more freely.

The knife spacing used for cross blocking will depend upon the initial seedling stand and upon the type of thinning to be used. A satisfactory method for predetermining the knife spacing for mechanical blocking that is to be followed by finger thinning is described in United States Department of Agriculture Leaflet 97, Cross-blocking Sugar Beets, and Circular 316, Agronomic Evaluation Tests on Mechanical Blocking and Cross-cultivation of Sugar Beets. By this method the proper set-up is determined from the germination stand and the desired after-thinning stand by using a set of curves (fig. 3), in which account is taken of the probability of blank blocks and actual loss of some blocks during thinning.

The germination stand is determined by averaging a number of counts. A 100-inch stick marked off in inch divisions and hinged in

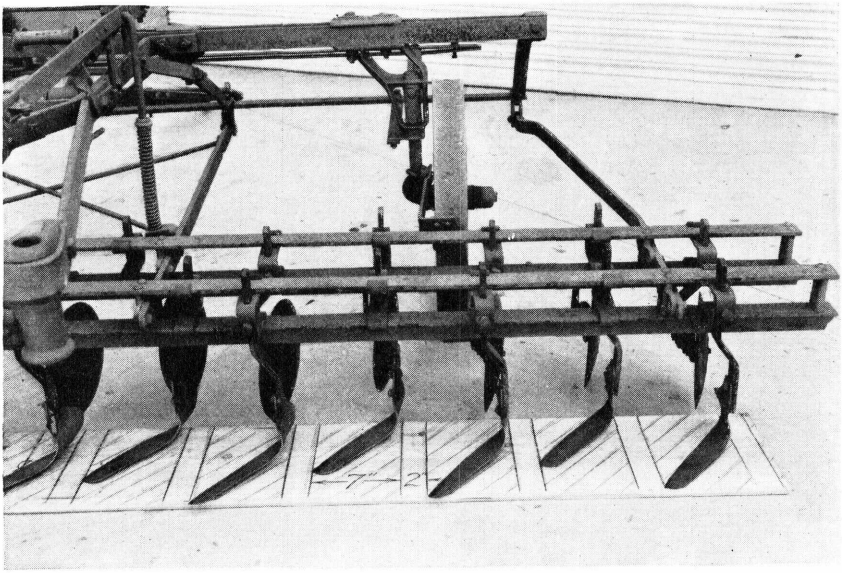

FIGURE 2.—Sugar-beet cross-blocker set-up with cultivator disks and 7-inch-cut weeder knives.

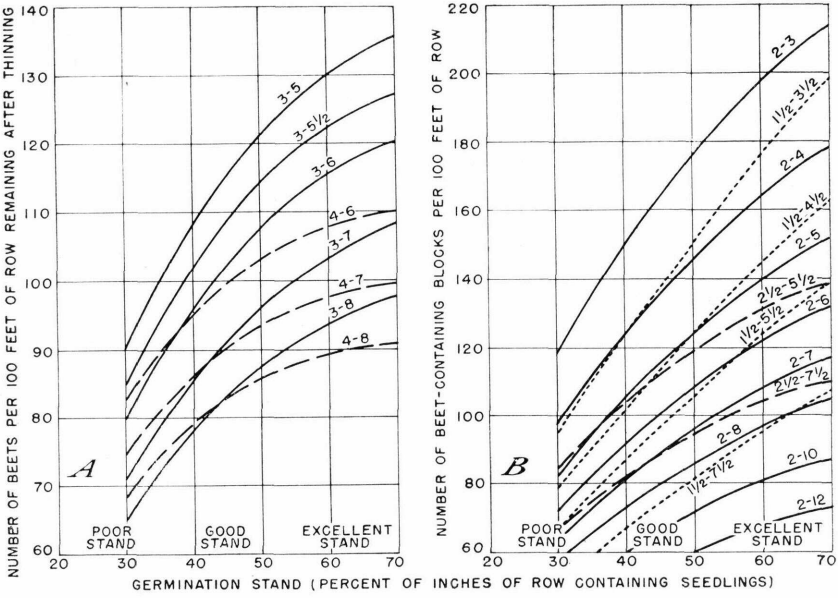

FIGURE 3.—*A*, Stand curves for mechanical blocking of sugar beets when 5-inch knives are used. The 3–5 curve indicates a 3-inch block remaining between cuts with 5-inch knives; from center to center of blocks, 8 inches; *B*, Stand curves for mechanical blocking of sugar beets when 3-inch knives are used. The 2–3 curve indicates that 2-inch blocks remain between cuts with 3-inch knives.

the middle for convenience in carrying is handy for counting. The stick is laid alongside a row, and the number of inch sections of row containing beets or the number of blanks are counted. This count gives directly the percent of inch sections containing seedlings. Counts are made at random in different parts of the field, at least 15 counts unless the field is very uniform, in which case 10 may be enough.

On the basis of the germination stand as so determined and the desired after-thinning stand, the proper set-up is determined from the curves. For example, suppose the average germination stand shows 55 percent of the inches of row contain beets and an after-thinning stand of approximately 100 beets per hundred feet is desired. Follow up the vertical line indicating a 55-percent germination stand (fig. 3, *A*) until it crosses the horizontal line marked 100. The nearest curve to this intersection is the 3–7 curve which indicates a 3-inch block and a 7-inch cut. To obtain this spacing, 7-inch knives would be set to leave 3-inch blocks, or in other words, set on 10-inch centers. A set-up indicated by one of the other curves near this intersection point can be used and may be more desirable if it indicates an available knife width.

Blocker Set-Up for Mechanical Thinning

The determination of a mechanical blocker set-up to be used with long-handled-hoe thining is less exacting. Inexactness in blocker set-up is compensated for in long-handled-hoe thinning by leaving multiple blocks in places to provide approximately the desired number of beets per 100 feet. In fact, a satisfactory after-thinning stand can be left by several different blocker set-ups though some set-ups will require more long-handled-hoe work than others. The blocker set-up is therefore not closely dependent on the germination stand. With reasonably good germination stands, a universal set-up can be used which, by varying the number of beets hoed out, will generally give satisfactory after-thinning stands. The final after-thinning stand should be approximately the same as that left after ordinary hand thinning. If an excessive number of beets is left after thinning, the harvest will be slowed down as there will be more beets to handle and more of them will be small.

In a further adaptation of this type of mechanical blocking the blocker is set up to cut out more of the beets and long-handled-hoe thining is omitted. A set-up for this type of blocking must be more exact and is more dependent on a uniform germination stand than blocking that is followed by thinning with the long-handled hoe.

Trials of mechanical thinning by the United States Bureau of Agricultural Chemistry and Engineering and others over a period of several years show average yields approximately 10 percent lower than when hand thinning was practiced. In many cases no decrease in yield resulted. The saving in hand labor ranged from approximately 70 percent up to 100 percent where no hand thinning followed the mechanical blocking, and the hand labor which remained was all long-handled-hoe work instead of stoop labor.

As pointed out earlier, each grower must decide whether the loss in yield which probably will result from mechanical thinning will be

sufficiently offset by labor saving. The possibility of total loss of the crop if labor for hand thinning cannot be obtained should also be considered.

It has been pointed out that different mechanical-blocker set-ups can be used to obtain satisfactory after-thinning stands when a long-handled hoe only is used to do the thinning or when no thinning is done. More long-handled-hoe work must be done in some cases than in others to reduce the blocked stand to a thinned stand comparable with usual hand-thinned stands.

Some set-ups will result in more singles than others. The narrower the blocks left, the greater the percentage of singles. Some mechanical blocking has been done with 1-inch or even slightly smaller blocks, but it is usually difficult to leave such narrow blocks without injury to the beets left. In general, blocks should be from 1½ to 2 inches wide.

The width of cut used will depend upon the knives available. With poorer germination stands and any one block size, narrower cuts should be used as more blocks are left per 100 feet and a better stand can be obtained. However, if knives with too narrow a cut are used, more long-handled-hoe work will be required. Furthermore, more cross-blocker knives will be required to cover a given width, and there is more chance for trash and cut-out beets to clog up on the knives and standards. The tool bar of the cultivator also gets heavy with the added number of knives and standards.

A good set-up for many conditions is 6-inch knives set on 8-inch centers, leaving 2-inch blocks. Such a set-up (cover picture) is designated as a 2–6 set-up on the curves in the charts (fig. 3, *A* and *B*). Regular 6-inch weeder knives with a small amount of suction are made by different manufacturers and are well adapted for cross blocking. The set-up is also well suited to usual tractor and beet-cultivator wheel spacings to cut out the wheel tracks. It usually leaves enough beet-containing blocks and yet does not require too much long-handled-hoe work on the better germination stands. Spaces between standards are wide enough to let trash and beets through. The amount of equipment is comparatively small. Adjacent beet blocks left as singles or reduced to singles are not too closely spaced, and where doubles are left the 16-inch spacing between alternate blocks is satisfactory. Then, too, if sufficient labor is available to finger-thin to singles this block spacing is satisfactory. A 2–7 spacing is also satisfactory where germination stands are good, and many growers already have satisfactory 7-inch weeder knives. However, it is usually necessary to replace cultivator and tractor wheels so as to have the wheel tracks cut out.

A 2–5 spacing may be preferred for lighter germination stands, but will probably necessitate cutting knives down to the desired width. This spacing, or even the use of narrower cuts, may be preferable where a single-seed planting at lighter seeding rates is used. With such plantings the percentage of beet-containing blocks which will be singles is higher, perhaps as high as 40 percent and as there are also more blocks per hundred feet, it is possible to secure a higher percentage of singles in the thinned stand.

Where no hoe thinning or finger thinning is used, it has been found desirable to reduce the block width to about 1½ inches, if soil and

other conditions will permit, and to use a cut of 7 inches to 8 inches for germination stands ranging from 40 to 50 percent, so that a sufficient number of beets will be cut out to obtain a satisfactory stand.

Adjusting the Blocker

Setting up a cultivator for blocking is facilitated by using a 1-inch by 12-inch board laid out with cross lines spaced in accordance with the blocks of beets to be left and those to be cut out (fig. 2). If the cultivator wheels are set up on 2-inch blocks, the marked board can be laid along under the tool bar with the tool bar down in working position, and with the cutting edges of the knives flat on the board. Then the knives can be set to cut out the proper strips. The board should be set with the center of a cut-out strip at the center of the cultivator so that the knives will be centered with the wheels, the outside knives will be at equal distances from the center, and the same length of marker can be used on each side of the cultivator.

The blocker set-up should begin with one knife set to cut out its strip in the center of the cultivator, thus cutting out the marker mark and the track of the center front tractor wheel, if the tractor is of that type, and the track of the caster wheel on the cultivator. It is somewhat better to have all the knives cut or throw toward the center of the cultivator, particularly if small blocks are being left, thus using all left-hand knives on the right half of the cultivator and right-hand knives on the left side. In this way it is possible to avoid having two vertical portions or dirt shields of knives facing each other in the center of the cultivator, an arrangement which might break out the blocks between these knives. Then, too, with this arrangement, if it is necessary to have a man on the cultivator to keep the knives free of trash and beets, he will find it is somewhat easier to dislodge the trash with a long stick.

If all knives are set either in front of or behind one tool bar, they all strike a beet row at the same time, and a jerky action may result if the ridges of soil are hard. However, if alternate knives with long blades are set on the front and rear tool bars, the heels of the front knives come close to the points or dirt shields of those on the rear, and blocks may be broken out. There is a better set-up which allows more clearance between long knives and easier passage of leaves and trash back through the knives. In this set-up alternate knives are on the front and back of the same tool bar, as shown in the cover picture. With shorter knives, as for a 5-inch cut or less, the alternate knives can be placed on the front and rear bars without reducing the clearance between knives, and such a set-up (fig. 4) allows increased space for trash to work back between the knives. It may be necessary to have at least some of the knives at the center of the cultivator placed on the front tool bar so that the cultivator caster wheel can swing all the way around without striking the knives when the machine is backed.

With square-turn knives it is somewhat better to have the standard on the inside or cutting side of the knife, especially if narrow blocks are left. This avoids having the standard push into and against the block. Bolt heads and nuts on the block side should also be as nearly

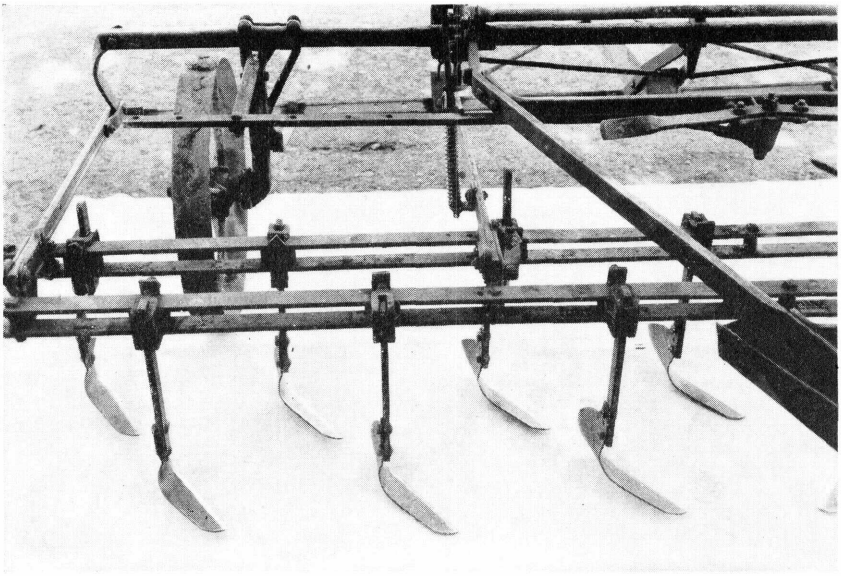

FIGURE 4.—Sugar-beet cross-blocking set-up with 2-inch blocks and 6-inch cuts.

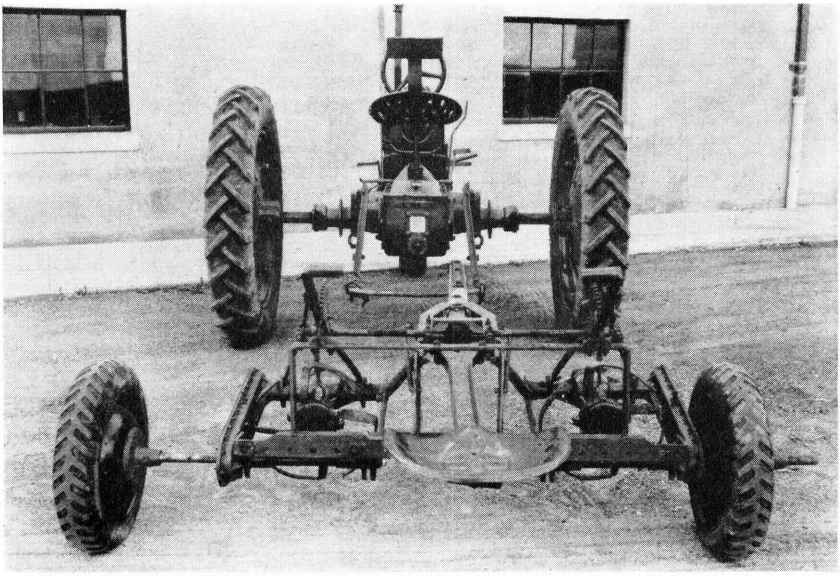

FIGURE 5.—Cotton chopper adopted for blocking bed-planted sugar beets.

streamlined as possible. With knives on which the dirt shield or vertical part of the knife is offset toward the cutting edge of the knife, it is better to have the standards on the outside of the knife as they are away from the block anyway.

A marker similar to that used on a beet planter is necessary on the blocker. It is usually set to leave a mark for the center of the blocker on the next trip. The distance out to the center of the mark from the center of the cultivator should be equal to the total width of the blocker measured over the outside knives, plus the width of one block. This distance is also equal to the number of knives on the cross blocker multiplied by their center-to-center spacing. In blocking, therefore, one block is also left between adjacent blocked strips as a "guess row."

Row Blockers

Most of the foregoing description applies to mechanical blocking done with a cross blocker. Under certain conditions, for example on bed-planted sugar beets, cross blockers cannot be used. Down-the-row or row blockers like that shown in figure 5, have been developed for such conditions. Some may prefer to use the row blockers on flat planting. Row blockers of one type or another are built by different manufacturers and usually utilize knives on a revolving cutter head. The knives are usually adjustable to obtain different-width blocks. The center-to-center distance between blocks can usually be changed by changing the speed of the cutter heads with respect to the forward travel or by changing positions or numbers of knives.

The directions previously given on spacings and size of blocks are equally applicable to row blockers though the spacings possible with the row blocker are often more restricted than with the cross blocker.

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